Stellar Evolution at Low Metallicity: Mass Loss, Explosions, Cosmology
*ASP Conference Series, Vol. **VOLUME**, 2006*
Lamers, Langer, Nugis and Annuk

NLTE wind models for SMC stars

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Abstract. We study stellar wind properties of selected late O stars in the Small Magellanic Cloud (SMC). We calculate NLTE line-driven wind models for these stars and compare predicted wind parameters with observed values. We found satisfactory agreement between theoretical and observed terminal velocities. On the other hand, predicted and observed mass-loss rates are in a good agreement only for higher mass-loss rates. For mass-loss rates lower than approximately $10^{-7}\,\mathrm{M}_\odot\,\mathrm{year}^{-1}$ we found large discrepancy between theoretical and observed values. We propose a new explanation of this effect based on dynamical decoupling of some atoms. Finally, we study the dependence of wind terminal velocities and mass-loss rates on metallicity.

1. Introduction

Hot stars wind properties depend on the stellar metallicity. Low-metallicity environment of SMC offers a possibility to study this dependence. For this purpose we apply wind models of Krtička & Kubát (2004).

Wind parameters of SMC stars predicted by our code were compared with that derived from observations by Puls et al. (1996), Bouret et al. (2003), Massey et al. (2004) and Martins et al. (2004).

2. Comparison of observed wind parameters

There is a relatively good agreement between predicted and observed terminal velocities (see Fig. 1) with few exceptions. The mean value of $v_\infty/v_{\mathrm{esc}} \sim 2.3$ is slightly lower than that of Galactic O stars. This may indicate that SMC terminal velocities are slightly lower than that of Galactic stars.

There is a good agreement between calculated and observed mass-loss rates for stars with high mass-loss rates ($\dot{M} \gtrsim 10^{-7}\,\mathrm{M}_\odot\,\mathrm{yr}^{-1}$). However, there is a significant disagreement between theoretical and observed values for stars with low mass-loss rates ($\dot{M} \lesssim 10^{-7}\,\mathrm{M}_\odot\,\mathrm{yr}^{-1}$). In this case the predicted mass-loss rates are more than ten times higher than the observed ones (Bouret et al. 2003).

3. Multicomponent effects

Hot star winds have a multicomponent nature which for low-density or low-metallicity flow influences the wind structure (e.g. Krtička & Kubát 2001). To

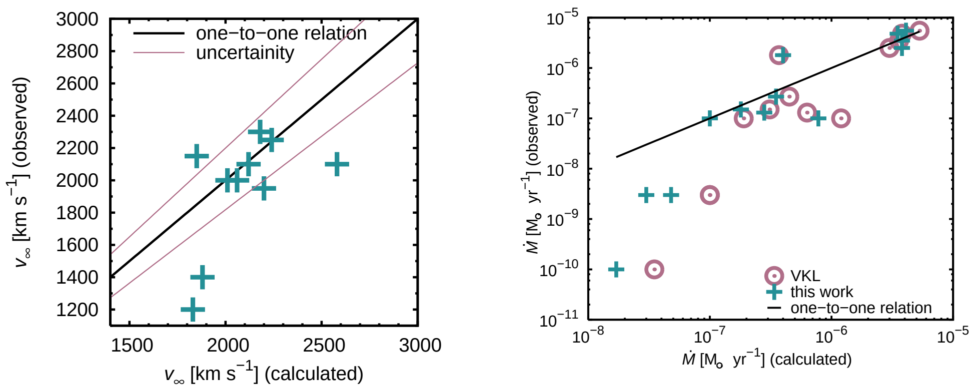

Figure 1. *Left:* Comparison of observed and predicted terminal velocities *Right:* Comparison predicted mass-loss rates by us and by Vink et al. (2001, hereafter VKL) and mass-loss rates derived from observation

test the importance of multicomponent effects we calculated models with wind components sulphur, remaining metals, H-He component and electrons.

For stars with relatively good agreement between observed and predicted mass-loss rates the multicomponent structure can be neglected. On the other hand, for stars with systematically too high predicted mass-loss rates either the decoupling of wind components occurs or the frictional heating is important. In this case the decoupling instability may lower the mass-loss rate. This may be an explanation of too high predicted mass-loss rates. However, only for one star studied the decoupling occurs for velocities lower than the terminal velocity. Improved model treatment may help to provide more consistent explanation.

4. Variations of wind parameters with metallicity

To study the variations of wind parameters with metallicity we recalculated wind models with the same stellar parameters, however with metallicity 1.5 times higher. For higher metallicity the mass loss rate is higher,

$$\dot{M} \sim Z^{0.70}. \tag{1}$$

The terminal velocity varies with metallicity only slightly, on average $v_\infty \sim Z^{0.05}$.

Acknowledgments. This work was supported by grants GA ČR 205/03/ D020, 205/04/1267 and by the Czech-Estonian academic interchange program.

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